

WE CLAIM:

1. A light frequency stabilization unit, comprising:
 - a birefringent element having a longitudinal axis, the birefringent element having an optical axis oriented to retard phase of polarized light propagating through the element substantially parallel to the longitudinal axis by a phase retardation amount proportional to a frequency of the polarized light;
 - a polarizer disposed to receive phase-retarded light from the birefringent element, the polarizer transmitting a portion of the phase-retarded light, a magnitude of the transmitted portion being determined by the phase retardation amount;
 - a first optical detector disposed to detect the transmitted portion of light, the first optical detector generating a first signal in response to the transmitted portion detected; and
 - an electronic error circuit coupled to the detector, the electronic error circuit generating a frequency stabilization signal in response to the first signal.
2. A frequency stabilization unit as recited in Claim 1 wherein the birefringent element is formed of a single birefringent material segment.
3. A frequency stabilization unit as recited in Claim 1, wherein the birefringent element includes a plurality of birefringent material segments disposed along the longitudinal axis, the phase retardation amount being responsive to the position of at least one of the birefringent material segments relative to the longitudinal axis.
4. A frequency stabilization unit as recited in Claim 1, wherein the birefringent element includes a plurality of birefringent material segments disposed along the longitudinal axis, thermal variation in a phase retardation amount provided by at least one of the pieces substantially compensating thermal variation in a phase retardation amount provided by at least another one of the pieces.

5. A frequency stabilization unit as recited in Claim 1, wherein the birefringent element has an optic axis direction oriented at an angle of approximately 45° with respect to a polarization direction of the input polarized light.
6. A frequency stabilization unit as recited in Claim 1, wherein the polarizer is oriented with a direction for maximum transmission angled at approximately 45° from the optic axis of the birefringent element.
7. A frequency stabilization unit as recited in Claim 1, wherein the polarized light includes a plurality of frequency-distinct signals, the phase retardation amount experienced by a first signal differing from the phase retardation amount experienced by at least a second signal by an integer multiple of π .
8. A frequency stabilization unit as recited in Claim 1 wherein the polarized light includes odd channels and even channels, the phase retardation amount experienced by the odd channels differing from the phase retardation amount experienced by the even channels by an odd integer multiple of $\pi/2$.
9. A frequency stabilization unit as recited in Claim 1 wherein the phase retardation amount is approximately a periodic function.
10. A frequency stabilization unit as recited in Claim 1 further comprising a second detector and a beam splitter, the beam splitter disposed to direct a portion of the input polarized light to the second detector, the second detector generating a second signal that is substantially independent of the frequency of the polarized light and indicative of optical power of the polarized light.
11. The frequency stabilization unit as recited in Claim 10, the error circuit additionally coupled to receive the second signal, and generate a light frequency stabilization signal in response to the first signal and the second signal.
12. A frequency-stabilized laser source comprising,
a laser with a frequency-control port, an operating frequency of the laser

being variable in response to a frequency control signal applied to the frequency control port;

a birefringent element having a longitudinal axis, the birefringent element having an optical axis oriented to retard phase of polarized light propagating through the element substantially parallel to the longitudinal axis by a phase retardation amount proportional to a frequency of the polarized light;

a polarizer disposed to receive phase-retarded light from the birefringent element, the polarizer transmitting a portion of the phase-retarded light, a magnitude of the transmitted portion being determined by the phase retardation amount;

a first optical detector disposed to detect the transmitted portion of light, the first optical detector generating a first signal in response to the transmitted portion detected; and

a feedback circuit disposed to receive the first signal and provide the frequency control signal to the laser frequency control port.

13. A frequency-stabilized laser as recited in Claim 12, wherein the birefringent element has an optic axis direction oriented at an angle of approximately 45° with respect to a polarization direction of the polarized light received from the laser.
14. A frequency stabilized laser as recited in Claim 12, further comprising a second detector and a beam splitter, the beam splitter disposed to direct a portion of the polarized light from the laser to the second detector to produce a second detector output signal indicative of polarized light power from the laser, the feedback circuit being coupled to receive the first signal and the second signal and to generate the frequency control signal in response to the first signal and the second signal.
15. A frequency stabilized laser as recited in Claim 12, wherein the birefringent element includes at least two birefringent material segments, the phase

retardation amount being responsive to the translation of at least one of the birefringent material segments relative to the longitudinal axis.

16. A frequency stabilized laser as recited in Claim 12, wherein the birefringent element includes a plurality of birefringent material segments disposed along the longitudinal axis, thermal variation in the phase retardation amount provided by one of the pieces substantially compensating thermal variation in phase retardation amount provided by at least another one of the pieces.
17. A frequency stabilized laser as recited in Claim 12, wherein the polarizer is oriented with a direction for maximum transmission angled at approximately 45° from the optic axis of the birefringent element.
18. A frequency stabilized laser as recited in Claim 12, wherein the feedback signal is approximately a periodic function of frequency of the laser.
19. An optical communications system, comprising:
 - a transmitting unit including a light frequency stabilization unit disposed to stabilize frequency of at least one optical signal, the frequency stabilization unit including
 - i) a birefringent element having a longitudinal axis, the birefringent element having an optical axis oriented to retard phase of polarized light propagating through the element substantially parallel to the longitudinal axis by a phase retardation amount proportional to a frequency of the polarized light,
 - ii) a polarizer disposed to receive phase-retarded light from the birefringent element, the polarizer transmitting a portion of the phase-retarded light, a magnitude of the transmitted portion being determined by the phase retardation amount,
 - iii) a first optical detector disposed to detect the transmitted portion of light, the first optical detector generating a first signal in response to the transmitted portion detected, and
 - iv) an electronic error circuit that generates a frequency stabilization signal in response to the first signal;

a receiving unit;

and an optical transport system coupled to carry optical signals from the transmitting unit to the receiving unit.

20. An optical communications system as recited in Claim 19, wherein the at least one optical signal includes a plurality of frequency-distinct signals, a phase retardation amount experienced by a first signal differing from a phase retardation amount experienced by at least a second signal by an integer multiple of π .
21. An optical communications system as recited in Claim 19 wherein the at least one signal includes odd channels and even channels, the phase retardation amount experienced by the odd channels differing from the phase retardation amount experienced by the even channels by an odd integer multiple of $\pi/2$.
22. An optical communication system as recited in Claim 19, wherein at least one of the receiver unit and transmitter unit is part of a transceiver unit.
23. A method for generating a light frequency stabilization signal, comprising:
retarding polarized light, using a birefringent element, by an amount that is proportional to a frequency of the polarized light;
analyzing the phase-retarded light with a polarization analyzer to produce an analyzed light beam;
measuring power of the analyzed light beam with a first detector to generate a first signal indicative of light frequency;
generating the light frequency stabilization signal in response to the first signal.
24. A method as recited in Claim 23 further comprising:
directing a portion of the polarized light to a second detector to generate a second signal indicative of light power; and
producing a power-corrected light frequency stabilization signal using the first and second signals.

25. A method as recited in Claim 23 including compensating thermal path length effects in the birefringent element.

26. A method for generating a light frequency stabilization signal as recited in Claim 23 including setting a phase retardation of the birefringent element by providing the birefringent element as at least two segments, each element having non-parallel faces and translating at least one of the at least two segments across the polarized light.

27. A method for stabilizing the frequency of a laser, comprising:
retarding phase of polarized light, generated by the laser, by an amount that is proportional to a light frequency;
analyzing the phase-retarded light with a polarizer to produce an analyzed light beam;
measuring power of the analyzed light beam with a first detector to generate a first signal indicative of laser frequency
generating a laser feedback signal in response to the first signal;
and adjusting frequency of the laser according to the feedback signal so as to stabilize the frequency of the laser.

28. A method as recited in Claim 27 further comprising directing a portion of the light from the laser to a second detector to generate a second indicative of laser power, and wherein generating the laser feedback signal includes generating the laser feedback signal in response to the second signal.